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UNITED STATES PATENT APPLICATION

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FOR: APPARATUS AND METHOD FOR APPLYING ADHESIVE TO TUBING

This application claims priority of U.S. Provisional Patent Application No. 60/324,813 filed September 17, 2001.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention relates to medical tubing, and more particularly relates to an apparatus and method for applying adhesive to a section of the outer surface of a length of tubing.

2. Background of the Invention

[0002] Many medical procedures employ a length of flexible plastic tubing for delivering fluid to a patient or for withdrawing bodily fluids from a patient. Opposed ends of the tubing typically are placed permanently in communication with plastic fittings. The typical plastic fitting includes opposed proximal and distal ends and a passage extending between the ends. Portions of the passage adjacent the proximal end of the fitting are dimensioned to receive an end of the flexible plastic tubing. The distal end of the plastic fitting may be configured for placement directly in communication with a patient or for placement in communication with another fitting.

[0003] The connection between the end of the plastic tubing and the proximal end of the plastic fitting must prevent separation of the tubing from the fitting in response to pulling forces and also must achieve a fluid-tight hermetic seal. An adhesive typically has been employed for this

one longitudinal side of the plastic tubing adjacent the end of the tubing. The end of the plastic tubing then is telescoped into the plastic fitting. The telescoping movement of the tubing is intended to urge the drop of adhesive completely into the annular space between the tubing and the fitting. This prior art procedure tends to cause some of the adhesive to be pushed into a bead on the tubing and externally of the proximal end of the plastic fitting. A sufficient accumulation of adhesive adjacent the proximal end of the fitting can affect the ability of external latches or shields on the fitting to perform properly. Additionally, it is difficult to assure that the adhesive has wicked properly into all areas between the plastic tubing and the fitting. Accordingly, it is difficult to ensure that a good hermetic seal has been achieved. A uniform distribution of the adhesive is difficult to achieve when the adhesive has a high viscosity. Hence, a low viscosity highly flowable adhesive typically is used for these purposes. This limits the selection of adhesives.

[0004] There also are disclosed attempts to secure plastic tubing to a fitting by first assembling the tubing to the fitting and then inserting adhesive into the annular space between the tubing and the fitting. The adhesive has been inserted, for example, with a small gauge needle and a low viscosity adhesive. This prior art approach again limits the types of adhesives that can be employed. Furthermore, this design is complicated and it is difficult to ensure that adhesive will flow uniformly into the annular space between a plastic tubing and the fitting.

3. Summary of the Invention

[0005] The subject invention is directed to an apparatus and method for applying a thin coat of adhesive uniformly to an outer circumferential surface region of a section of plastic tubing adjacent an end of the tubing. The apparatus comprises a pair of grippers that are selectively movable toward and away from one another. Each gripper may be formed from a metallic plate material with opposite front and rear faces and a tube-mating face extending between the front and rear faces. The front and rear faces of each gripper are spaced apart a thickness that is equal to or greater than the length of the tubing to which the adhesive is to be applied.

[0006] The tube-mating face of each gripper includes a concave adhesive transfer area located centrally between and substantially transverse to the front and rear faces. The concave shape of the adhesive transfer area in each gripper conforms to the external shape of the tubing and forms a common longitudinal axis with the grippers. Most tubing is substantially cylindrical, and hence the tube transfer areas define a concave semi-cylindrical surfaces. The dimensions of the adhesive transfer areas of the grippers are selected to enable the adhesive transfer areas to nest completely around the tubing without occluding the tubing.

[0007] The tube-mating face of each gripper further is characterized by front and rear counterbores extending into the respective front and rear faces of the gripper and symmetrically disposed around opposite ends of the adhesive transfer area. The counterbores, however, define a larger cross-sectional area than the adhesive transfer area.

[0008] The tube-mating face of each gripper further is characterized by a vacuum channel spaced from the adhesive transfer area and extending between the front and rear counterbores. The channels in the grippers are disposed to substantially register with one another when the grippers move toward one another.

[0009] Each gripper further includes an adhesive dispensing passage for delivery of adhesive to the adhesive transfer area of the gripper.

[0010] At least one gripper further includes a vacuum passage extending into communication with the vacuum channel and configured for communication with a vacuum source. Thus, the vacuum passage enables a low pressure to be applied to the channel and to the counterbores with which the vacuum channel communicates.

[0011] The apparatus is employed by delivering a controlled amount of adhesive through the respective adhesive dispensing passages and into the adhesive transfer areas. The flow of adhesive into the adhesive transfer areas may commence before the tubing is positioned between the grippers. The end of the tubing then is disposed between the grippers, and the grippers are

moved to engage around opposite sides of the tubing. Thus, the tubing is engaged in the adhesive transfer areas, but without a tight gripping that could occlude the tubing. The adhesive preferably has already commenced flowing into the adhesive transfer areas when the grippers are closed around the tubing so that adhesive in the adhesive transfer areas is urged continuously and circumferentially around the section of the tubing to which the adhesive is to be applied. A vacuum is applied at the vacuum passage typically as the grippers are being closed around the tubing. The vacuum draws excess adhesive into the counterbores. The adhesive then flows from the counterbores through the channel and through the vacuum passage for collection and/or recirculation. The vacuum contributes to a uniform thin coating of adhesive around the outer circumferential surface of the tubing and further contributes to removal of excess adhesive from areas where an adhesive build-up could affect performance of the medical device to which the tubing is connected. Additionally, the adhesive removal steps may be carried out simultaneously with the adhesive application steps, and as a result additional cleaning steps are not required for removing excess adhesive.

[0012] There is a definite need in the art of adhesive application for improvements which can overcome problems which arise with prior art apparatus. The present invention is directed to overcoming these problems and fulfilling this need.

4. Brief Description of the Drawings

[0013] FIG. 1 is a schematic view of an adhesive applicator apparatus of the subject invention in a load position that permits loading of a section of tubing into the apparatus.

[0014] FIG. 2 is a perspective view of the grippers of the apparatus shown in FIG. 1.

[0015] FIG. 3 is a front elevational view, partly in section, of the first gripper.

[0016] FIG. 4 is an elevational view of the tubing mating face of the first gripper.

[0017] FIG. 5 is a front elevational view of the second gripper of the apparatus.

[0018] FIG. 6 is an elevational view of the mating face of the second gripper.

[0019] FIG. 7 is a perspective view of the first gripper with a section of tubing loaded therein.

[0020] FIG. 8 is a schematic view similar to FIG. 1, but showing the grippers engaged around the section of tubing.

[0021] FIG. 9 is an enlarged view of portions of the grippers engaged with the tubing.

[0022] FIG. 10 is an exploded cross-sectional view showing the tubing with the adhesive applied thereto and in proximity to a plastic fitting.

[0023] FIG. 11 is a cross-sectional view of the tubing fully mounted in the fitting.

5. Detailed Description of the Invention

[0024] An apparatus for applying adhesive to an outer circumferential surface of a short section of plastic tubing is identified generally by the numeral **10** in FIG. 1. Apparatus **10** includes first and second grippers **12** and **14** respectively. Grippers **12** and **14** are mounted to a pneumatic actuator cylinder assembly **16** which is operative for moving grippers **12** and **14** from a load position shown in FIG. 1 to a dispense position described and illustrated below. Grippers **12** and

14 are spaced from one another in the load position shown in FIG. 1, but move toward one another in the dispense position.

[0025] Apparatus 10 further includes an adhesive supply 18 that communicates with first and second valves 22 and 24 respectively. First and second valves 22 and 24 communicate respectively with first and second grippers 12 and 14 and are operative for selectively directing adhesive from adhesive supply 18 to first and second grippers 12 and 14.

[0026] Apparatus 10 further includes a vacuum source 26 that communicates with first gripper 12.

[0027] First gripper 12 is machined from a stainless steel material and includes opposite substantially parallel planar front and rear faces 28 and 30. Front and rear faces 28 and 30 are spaced from one another by a distance "a", as shown in FIG. 2, that equals or slightly exceeds the length of tubing to which adhesive is to be applied. First gripper 12 is an elongate structure with an upper mounting end 32 and a lower tube engaging end 34. Mounting end 32 is characterized by a mounting aperture 36 for mounting first gripper 12 to pneumatic actuating cylinder assembly 16. First gripper 12 also is characterized by an adhesive supply face 38 and an opposed tube mating face 40 each of which extends between the front and rear faces 28 and 30.

[0028] Tube mating face 40 is characterized by a generally semi-cylindrical concave adhesive transfer area 42 generated about an axis aligned substantially perpendicular to front and rear faces 28 and 30 of first gripper 12. Adhesive transfer area 42 defines a diameter equal to or slightly greater than the outside diameter of the length of tubing to which adhesive will be applied. An adhesive supply passage 44 extends through first gripper 12 from adhesive supply face 38 to adhesive transfer area 42, as shown in FIG. 3. More particularly, adhesive supply passage 44 intersects adhesive transfer area 42 at a location 46 disposed centrally between front and rear faces 28 and 30 and at an above-center position on a side of the axis of adhesive transfer area 42 further from lower end 34 of first gripper 12, as shown in FIGS. 3 and 4.

[0029] Front and rear counterbores **48** and **50** extend into front and rear faces **28** and **30** of first gripper **12**. Front and rear counterbores **48** and **50** are cross-sectionally larger than adhesive transfer area **42** and are substantially symmetrically disposed around opposite ends of adhesive transfer area **42**.

[0030] A generally U-shaped vacuum channel **52** is formed into tube mating face **40** of first gripper **12** at a location between lower end **34** of first gripper **12** and adhesive transfer area **42**. More particularly, vacuum channel **52** has a front end **54** communicating with front counterbore **48** and a rear end **56** communicating with rear counterbore **50**. A vacuum passage **57** extends through first gripper **12** from adhesive supply face **38** to a location in vacuum channel **52** approximately centrally between front and rear ends **54** and **56** of vacuum channel **52**.

[0031] Second gripper **14** is structurally similar to first gripper **12**. More particularly, second gripper **14** also is machined from a stainless steel material and has substantially parallel planar front and rear faces **58** and **60**. Front and rear faces **58** and **60** are spaced from one another by a distance "a" substantially equal to the thickness of first gripper **12**. Second gripper **14** further includes an upper mounting end **62** and a lower tube engaging end **64** substantially as with first gripper **12**. A mounting aperture **66** extends through second gripper **14** to mount second gripper **14** securely on pneumatic actuating cylinder **16**. Second gripper **14** further includes an adhesive supply face **68** and a tube mating face **70**. A concave semi-cylindrical adhesive transfer area **72** is formed in tube mating face **70** at a location to register with adhesive transfer area **42** of first gripper **12** when grippers **12** and **14** are moved from the load position shown in FIG. 1 to the dispense position around a section of tubing. Second gripper **14** further includes an adhesive supply passage **74** that extends from adhesive supply face **68** to adhesive transfer area **72**. The intersection of adhesive supply passage **44** with adhesive transfer area **42** is at an above center position as shown in FIG. 6 and as described with respect to first gripper **12**.

[0032] Front and rear counterbores **78** and **80** extend into front and rear faces **68** and **70** of second gripper **14** at locations symmetrically surrounding opposite ends of adhesive transfer area **72**. A U-shaped vacuum channel **82** is formed in tube mating face **70** at locations spaced from

adhesive transfer area **72**. Vacuum channel **82** is disposed to register with vacuum channel **52** when first and second grippers **12** and **14** are moved into the dispense position described further below. In the illustrated embodiment, second gripper **14** is not provided with a vacuum passage comparable to vacuum passage **57** formed in first gripper **12**.

[0033] Apparatus **10** is used with a length of PVC tubing **90** as shown in FIG. 7. Tubing **90** has an end **92** and an outer circumferential surface **94** extending entirely along the length of tubing **90**. Portions of outer circumferential surface **94** in proximity to end **92** are to be hermetically sealed and fixedly secured in a plastic fitting intended for medical applications. Adhesive is applied to outer circumferential surface **94** of tubing **90** adjacent end **92** by loading end **92** of tubing **90** into the space between adhesive transfer areas **42** and **72** of first and second grippers **12** and **14**. A flow of adhesive material then is initiated by actuating first and second valves **22** and **24** respectively to permit adhesive to flow from first and second valves **22** and **24** into adhesive passages **44** and **74**, and hence into adhesive transfer areas **42** and **72**. First and second grippers **12** and **14** are moved under the action of pneumatic actuating cylinder assembly **16** toward one another and into surrounding relationship with tubing **90**, as shown in FIGS. 8 and 9. At this point, adhesive **96** has entered upper regions adhesive transfer areas **42** and **72** and flows slightly downward due to gravitational forces. Movement of grippers into the dispense position of FIGS. 8 and 9 urges adhesive **96** against outer circumferential surface regions **94** of tubing **90** adjacent end **92**. The relative cross-sectional dimensions of adhesive transfer areas **42** and **72** help to achieve a smooth uniform distribution of adhesive **96** circumferentially around outer surface **94** of tubing **90** adjacent end **92**.

[0034] Substantially simultaneously with movement of grippers **12** and **14** into the dispense position of FIGS. 8 and 9, vacuum source **26** is activated to create a low pressure that communicates with vacuum passage **57** and registered vacuum channels **52** and **82**. Channels **52** and **82** communicate with registered front counterbores **48** and **78** and registered rear counterbores **50** and **80**. Hence, adhesive **96** is drawn toward the counterbores by the low pressure to ensure the continuous circumferential coating of adhesive around outer surface **94** of tubing **92**. Excess adhesive **96** then is drawn away from counterbores **48**, **50**, **78** and **80**, through

registered vacuum channels **52** and **82** and through vacuum passage **57** in first gripper **12**. Actuating cylinder assembly **16** then is actuated again to move grippers **12** and **14** from the FIG. 8 condition into the FIG. 1 position. Tubing **90** is removed from apparatus **10** and has a thin uniform coating of adhesive **96** as shown in FIG. 10. End **92** of tubing **90** may be inserted into fitting **98** as shown in FIG. 11, and may be subjected to UV radiation for curing. As illustrated schematically in FIG. 11, substantially no excess adhesive exists either at the opening of fitting **98** or at end **92** of tubing **90**. Hence, fluid flow through tubing **90** is not impeded and latches or other safety structures on fitting **98** are not affected by excess adhesive **96**.